U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

2020 VTO Annual Merit Review
Monday, June 1, 2020

Energy Efficient Mobility Systems

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Vehicle Technologies Office

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Heather Croteau
Prasad Gupte



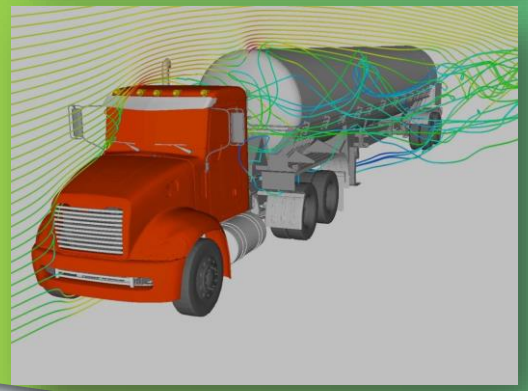


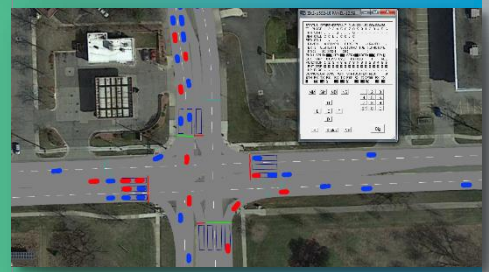

VTO DEVELOPS SOLUTIONS AT ALL LEVELS







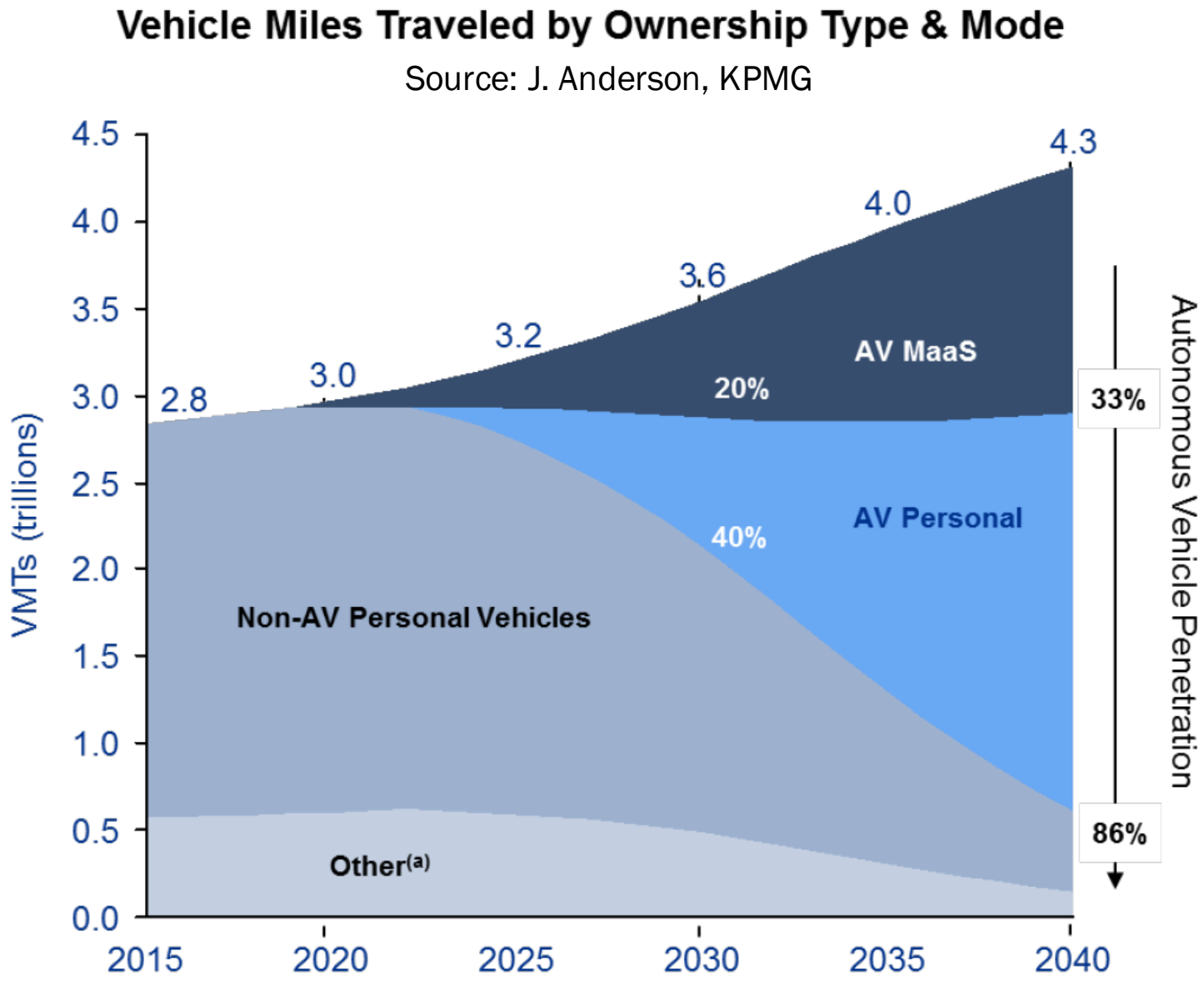



Component — Vehicle — Transportation System

WHAT IS EEMS?

Source: Ford Motor Company

WHAT IS EEMS?


Vehicle Miles Traveled by Ownership Type & Mode
Source: J. Anderson, KPMG
VMTs (trillions)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.8
3.0
3.2
3.6
4.0
4.3
AV MaaS
20%
AV Personal
40%
Non-AV Personal Vehicles
Other(a)
33%
86%
Autonomous Vehicle Penetration
2015
2020
2025
2030
2035
2040

WHAT IS EEMS?

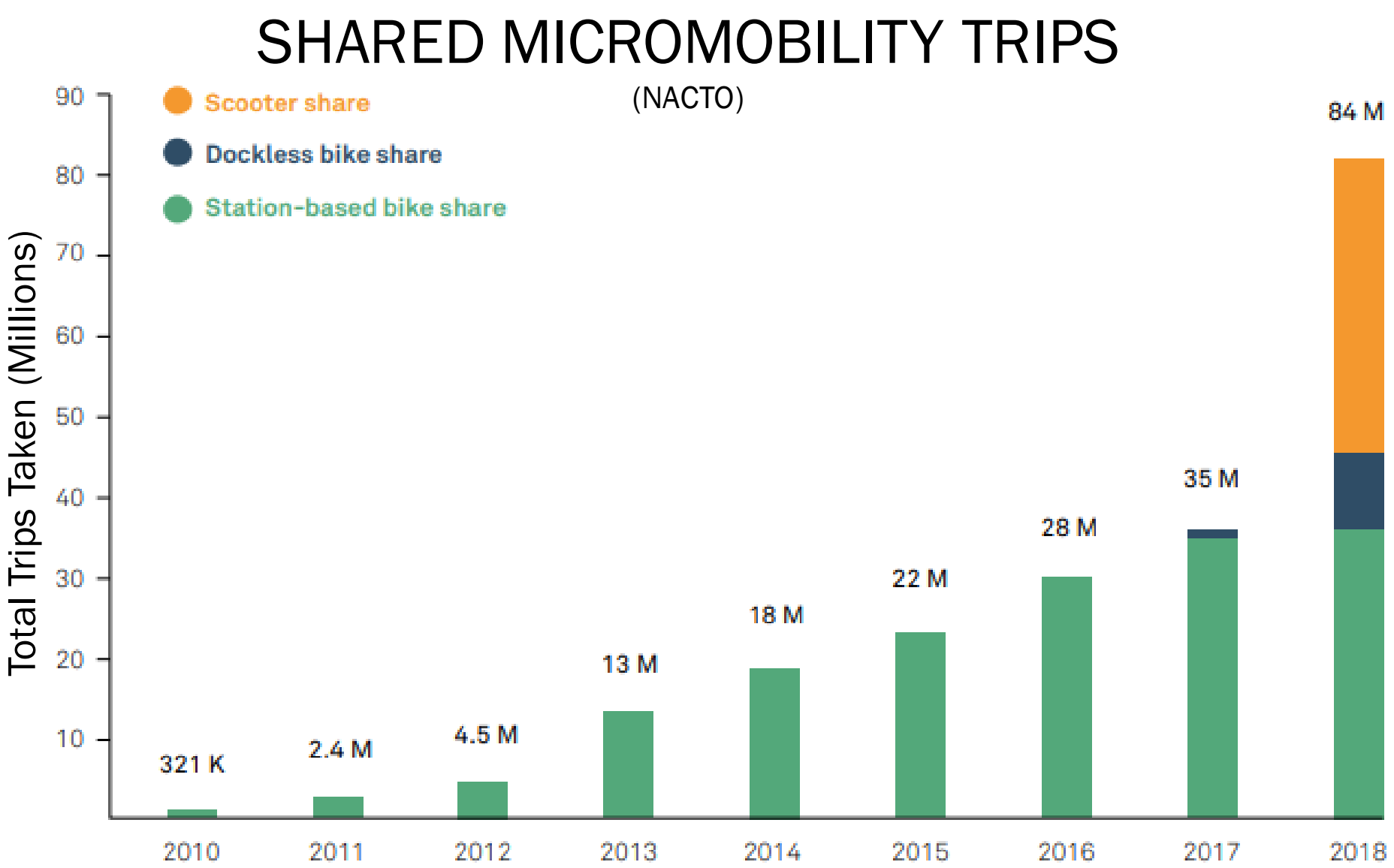
Source: melissamn/Shutterstock


Source: Pinterest


Source: Alain Jocard/Getty


Source: Spin

WHAT IS EEMS?


SHARED MICROMOBILITY TRIPS
(NACTO)
Scooter share
Dockless bike share
Station-based bike share
Total Trips Taken (Millions)
90
80
70
60
50
40
30
20
10
321 K
2.4 M
4.5 M
13 M
18 M
22 M
28 M
35 M
84 M
2010
2011
2012
2013
2014
2015
2016
2017
2018

WHAT IS EEMS?


Source: InBin

Source: Shutterstock

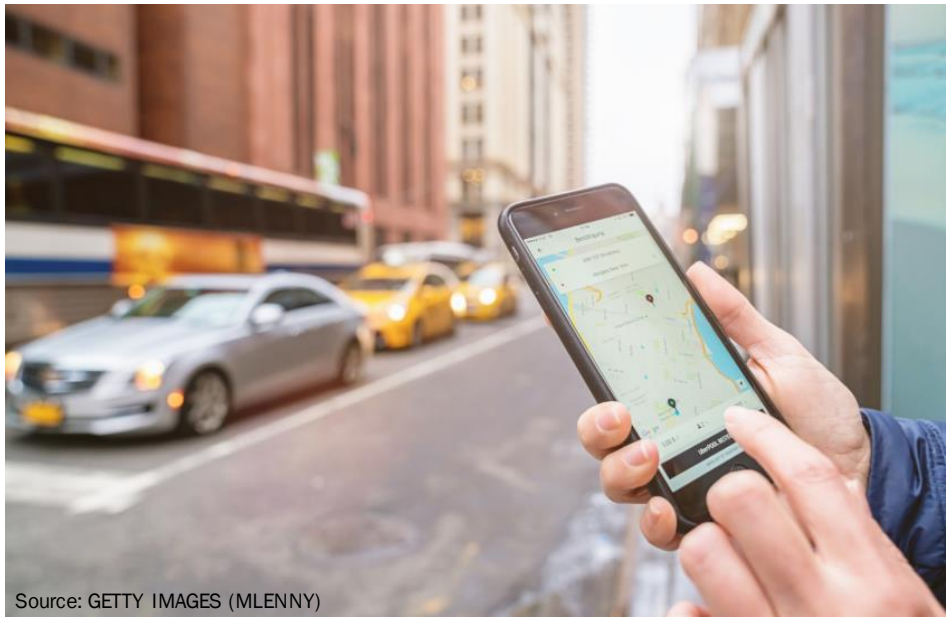

Source: iStock

Source: Kevork Djansezian/Getty Images

WHAT IS EEMS?


USPS Annual Shipping & Package Volume
BILLIONS OF PACKAGES
0
1
2
3
4
5
6
7
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
YEAR
Shipping/Package Volume

WHAT IS EEMS?


Source: GETTY IMAGES (MLENNY)

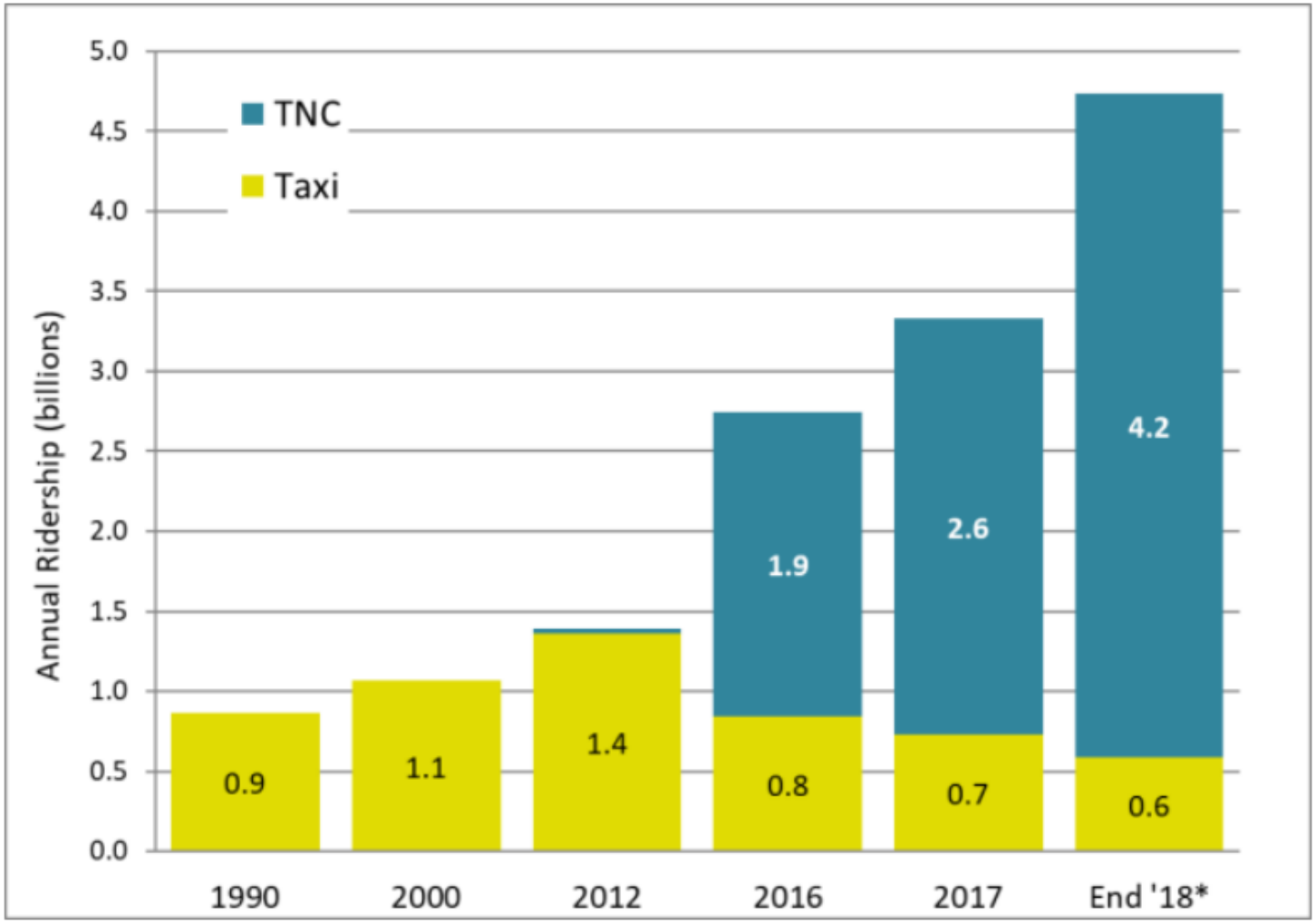
Source: AirportImprovement.com

Source: David Goldman/AP

WHAT IS EEMS?

TNC & Taxi Ridership in the U.S., 1990-2017

Bruce Shaller, Shaller Consulting



WHAT IS EEMS?

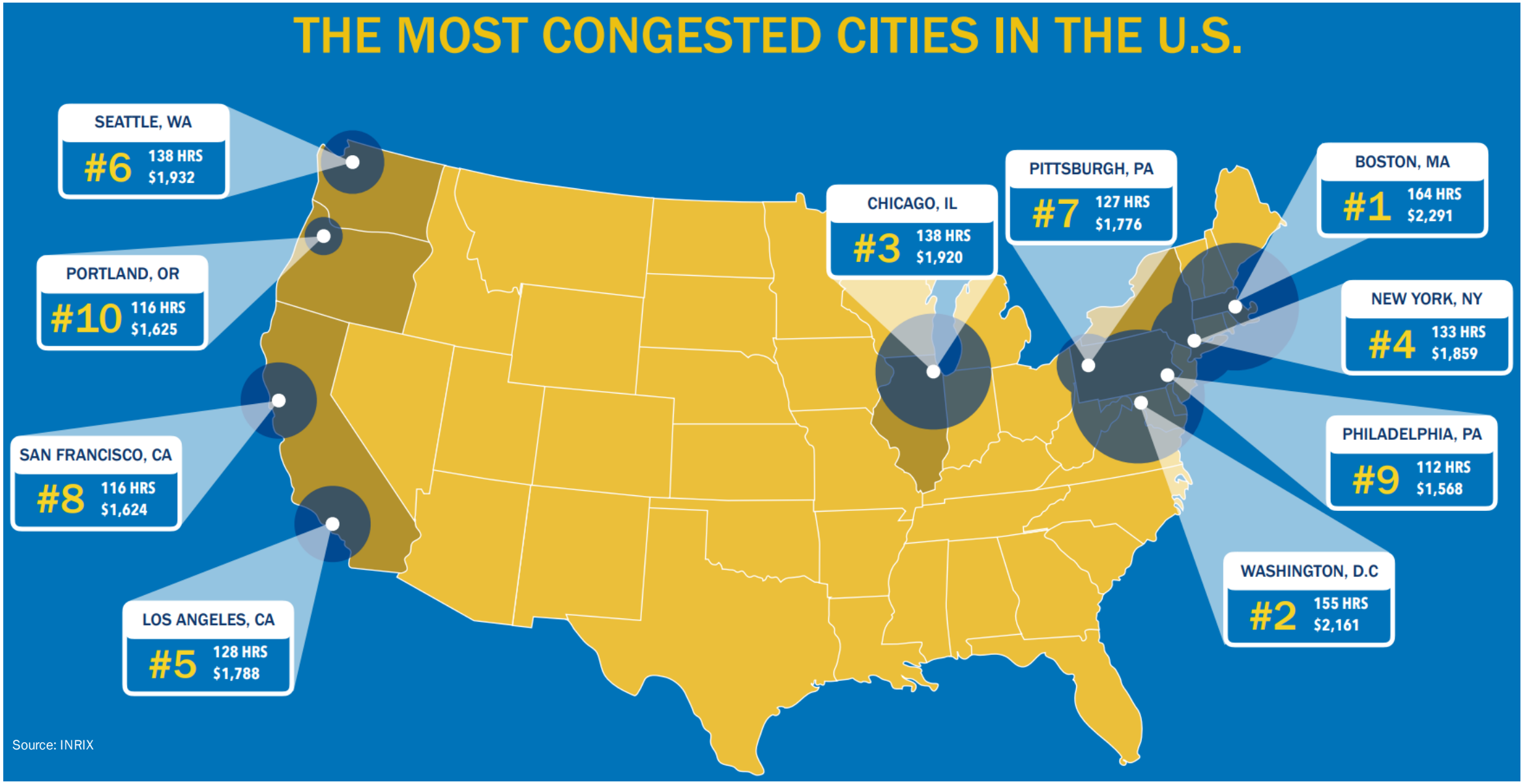
Source: WTOP

Source: The Star


Source: GEOT


Source: AP

WHAT IS EEMS?

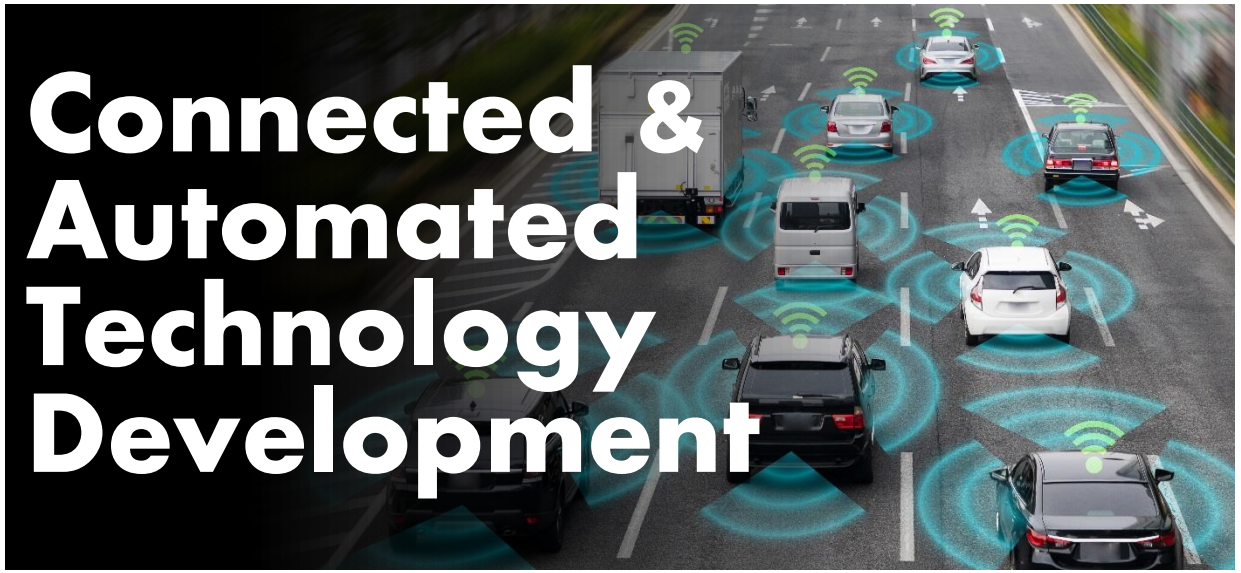

THE MOST CONGESTED CITIES IN THE U.S.
SEATTLE, WA
#6 138 HRS $1,932
PORTLAND, OR
#10 116 HRS $1,625
SAN FRANCISCO, CA
#8 116 HRS $1,624
LOS ANGELES, CA
#5 128 HRS $1,788
CHICAGO, IL
#3 138 HRS $1,920
PITTSBURGH, PA
#7 127 HRS $1,776
BOSTON, MA
#1 164 HRS $2,291
NEW YORK, NY
#4 133 HRS $1,859
PHILADELPHIA, PA
#9 112 HRS $1,568
WASHINGTON, D.C
#2 155 HRS $2,161
Source: INRIX

EEMS PROGRAM STRUCTURE

U.S. DEPARTMENT OF ENERGY
SMARTMOBILITY
Systems and Modeling for Accelerated Research in Transportation



AI
HPC
BIG DATA

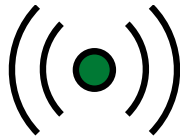


Simulation
&
Evaluation


EEMS RESULTS

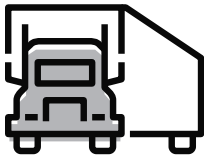
U.S. DEPARTMENT OF ENERGY SMARTMOBILITY
Systems and Modeling for Accelerated Research in Transportation

Completed 3+ Year Consortium Effort to Understand Energy & Mobility Implications of Advanced Transportation Systems



CONNECTED AND AUTOMATED VEHICLES

MOBILITY DECISION SCIENCE



MULTI-MODAL FREIGHT

URBAN SCIENCE

ADVANCED FUELING INFRASTRUCTURE

Argonne NATIONAL LABORATORY

BERKELEY LAB

NREL NATIONAL RENEWABLE ENERGY LABORATORY

OAK RIDGE National Laboratory

INL Idaho National Laboratory

eems085 eems074 eems023 eems057 eems011 eems058 eems030
eems044 eems045 eems020 eems033 eems039 eems081 eems030
eems016 eems059 eems027 eems060 eems034 eems078 eems035

EEMS RESULTS

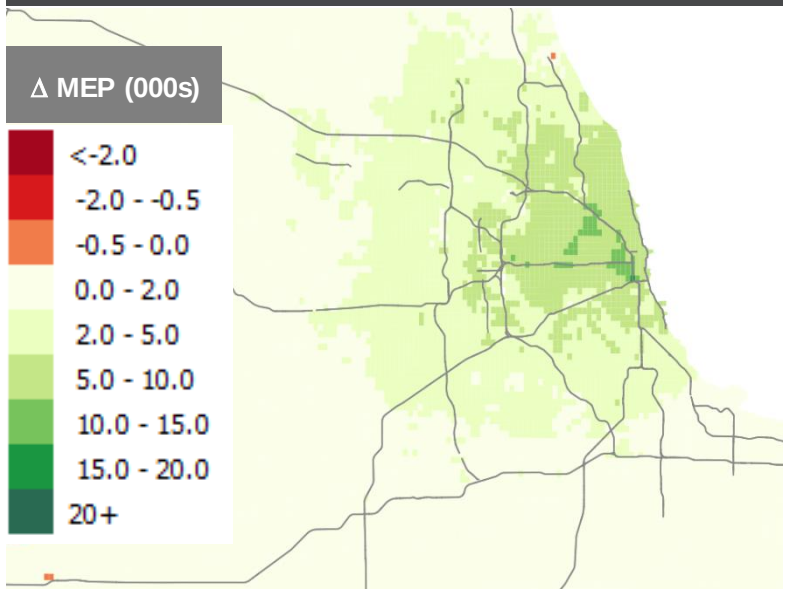
U.S. DEPARTMENT OF ENERGY
SMARTMOBILITY
Systems and Modeling for Accelerated Research in Transportation

Completed 3+ Year Consortium Effort to Understand Energy & Mobility Implications of Advanced Transportation Systems

Completed 3+ Year Consortium Effort to Understand Energy & Mobility Implications of Advanced Transportation Systems

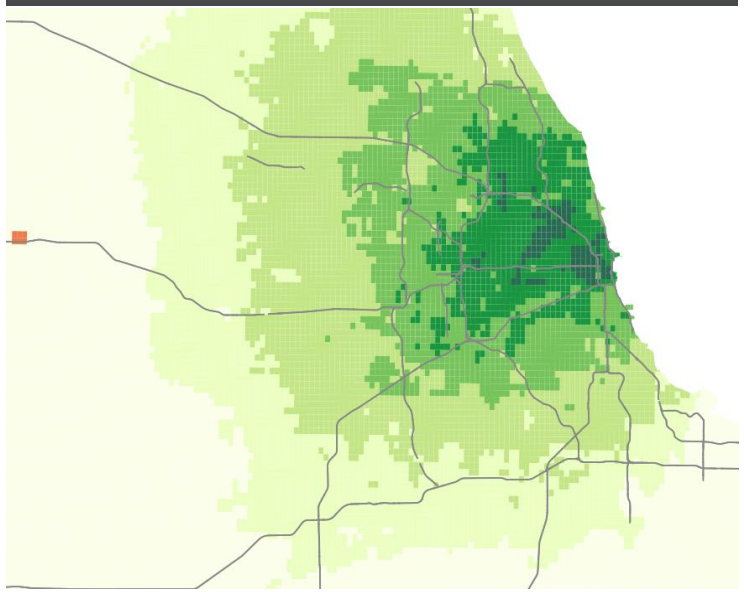
CHICAGO

Δ MEP: A (Sharing) vs. short term baseline



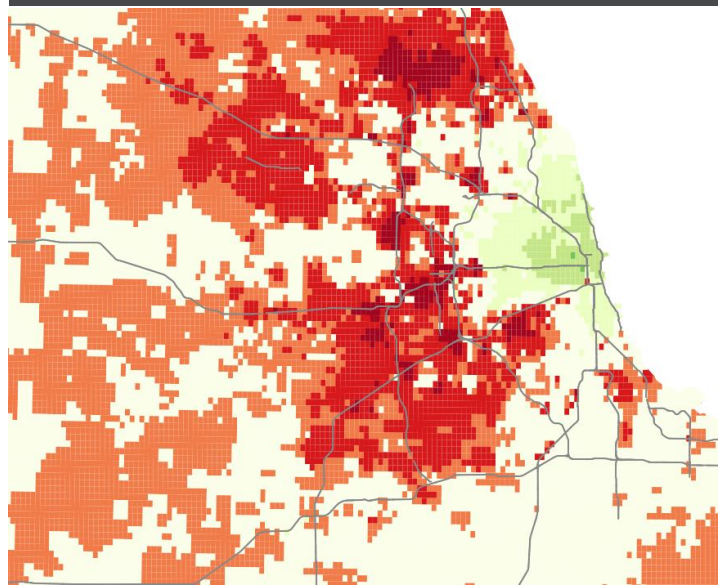
- Faster travel speed (+12%)
- Increased ridesharing
- Increased Transit use

Δ MEP: B (SAV) vs. long term baseline



- Faster travel speed (+17%)
- Reduced TNC cost and wait
- Concentrated in transit rich areas

Δ MEP: C (AV) vs. long term baseline

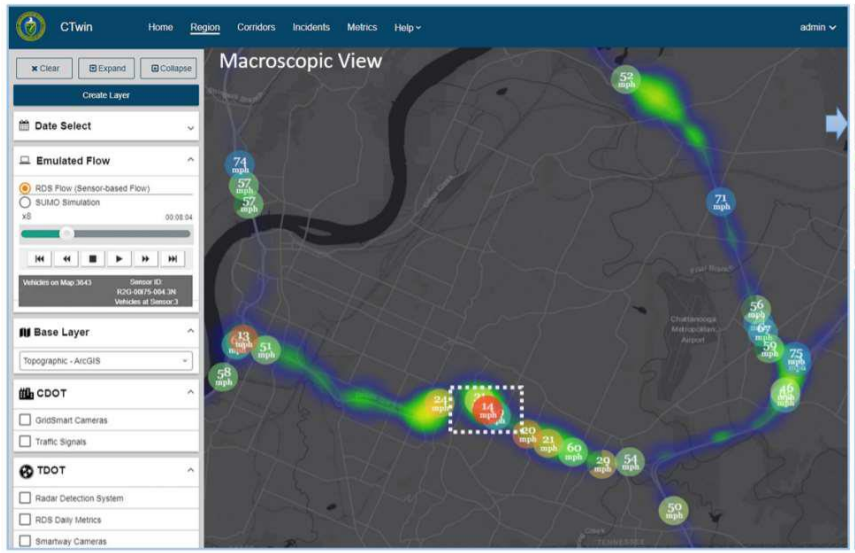


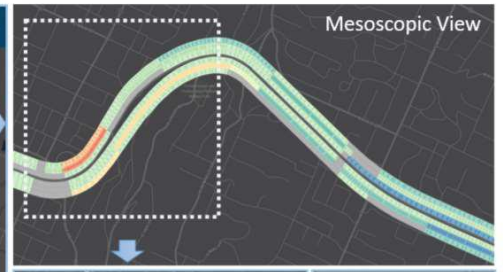
- Lower travel speed in suburbs(-16%)
- In Chicago, higher SAV fleet and transit use
- **Does not account for increased productivity during travel**

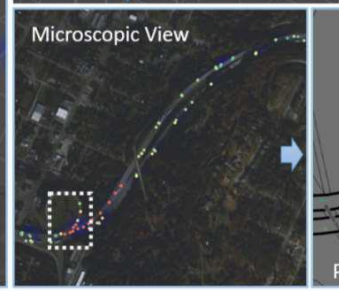
Argonne NATIONAL LABORATORY

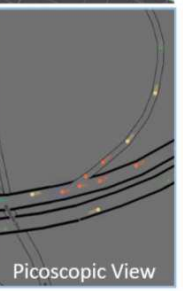
Demonstrated 18% Energy Reduction Through HPC-Enabled Cyber-Physical Control of Transportation Infrastructure in Chattanooga

- Created data science algorithms for real-time situational awareness
- Developed “digital twin” to simulate optimization algorithms and interface with signal control hardware
- Implementation/evaluation on Shallowford Road corridor









NREL NATIONAL RENEWABLE ENERGY LABORATORY

OAK RIDGE National Laboratory

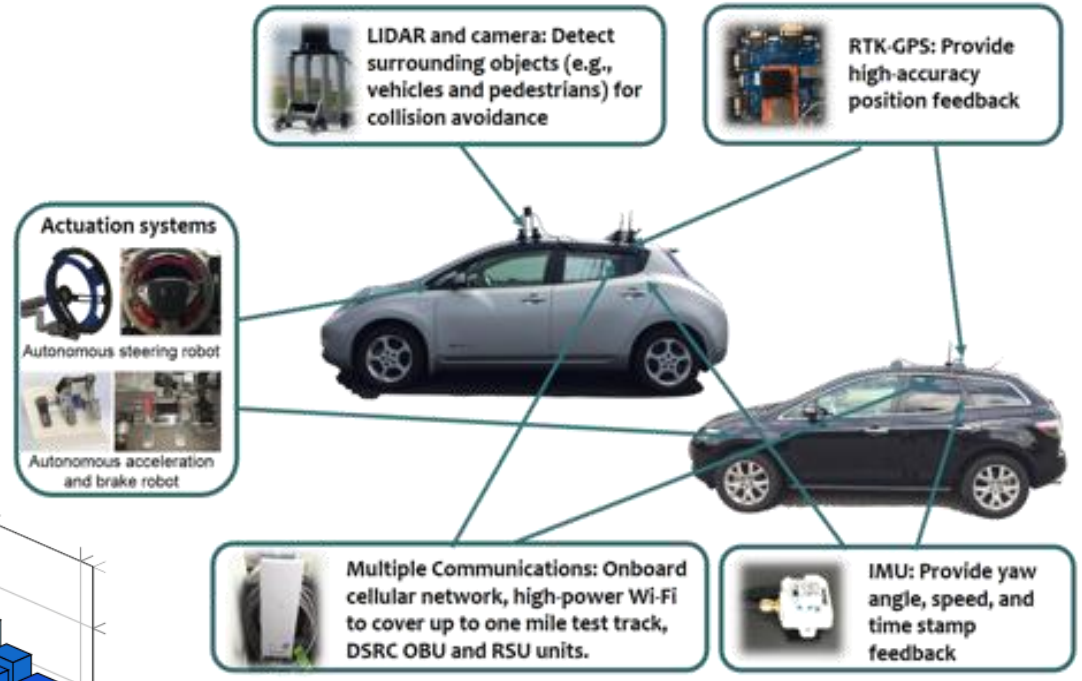
Commissioned New Connected & Automated Vehicle Environment

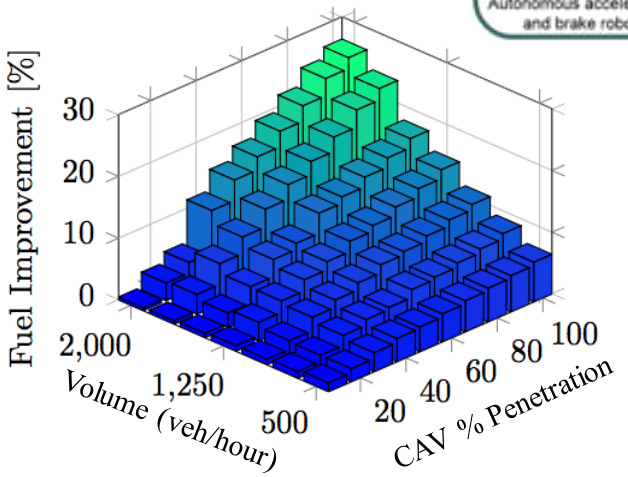
- Steerable dynamometer allows vehicle operation in virtual traffic environments
- "Digital Twin" of ACM track environment enables lab-to-track testing of CAV technologies (eems082)
- Co-simulation of vehicle dynamics, traffic, communications and controls

EEMS RESULTS

Demonstrated >20% Reduction in Traffic-wide Fuel Use Through Novel Predictive Automated Vehicle Guidance Algorithms

- Developed anticipative vehicle guidance algorithms
- Tested using traffic microsimulation and vehicle energy consumption models
- Developed communications protocols and experimentally evaluated in vehicle-in-the-loop environment





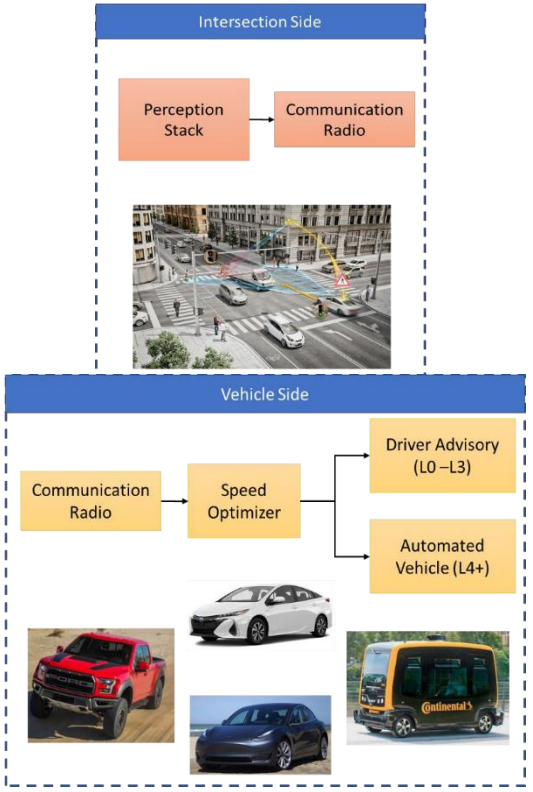
EEMS: NEW PROJECTS UNDERWAY

Southwest Research Institute (eems084)

SOUTHWEST RESEARCH INSTITUTE

Energy Efficient Maneuvering of Connected Automated Vehicles with Situational Awareness at Intersections

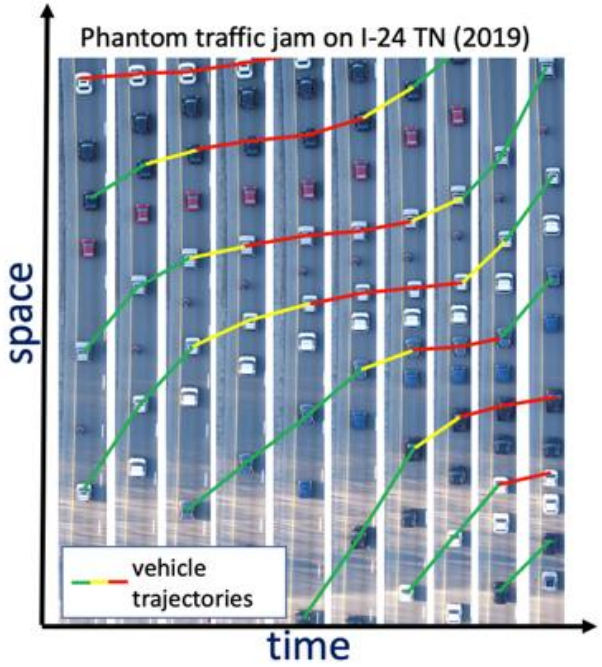
- Full preview information at intersections provided through connectivity
- "Intelligent Intersection" infrastructure-based sensing & perception stack
- 15% system-wide energy reduction target



UC Berkeley (eems083)

CIRCLES: Congestion Impact Reduction via CAV-in-the-loop Lagrangian Energy Smoothing

- Mitigates "phantom traffic jams"
- 5% penetration results in 10% system-wide energy reduction
- Large-scale validation on TN public road (100 vehicles out of 2000)



SMARTER
VEHICLES

SMARTER
TRAVELERS

SMARTER
SYSTEM

MORE **MOBILITY**

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Energy Efficient Mobility Systems

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